A critical appraisal of "Corticospinal adaptations and strength maintenance in the immobilized arm following 3 weeks unilateral strength training"

By

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Abstract:

This term paper is assessing the strengths and weaknesses of the introduction, methods, results and discussion section of the article "Corticospinal adaptations and strength maintenance in the immobilized arm following three weeks unilateral strength training." After assessing strengths and weaknesses, the overall validity and clinical significance of the paper is discussed.

Key words in this article are: Cross education, immobilization, and strength training.

Introduction:

Immobilization of a limb is a very common practice when it comes to someone with an injury or a patient that is post-surgery. Immobilization is an important part of the healing process, but can be detrimental to the muscle in the involved limb with respect to muscle size and strength. Due to the muscle atrophy when immobilized, many doctors and therapists prescribe strength training of the non-immobilized limb to aid in muscle retention of the immobilized limb. The reason behind this muscle retention has been attributed to corticospinal mechanisms. The article I have done this critical appraisal over does test the strength maintenance of the immobilized limb after a strength training regime, but it also tests the corticospinal responses to the training. My appraisal of this article is to assess the validity of the experiments done, as well as try to answer my clinical question of "Does unilateral strength training help overall strength gains in an immobilized limb through cross education?" If proven, this cross education technique could be used to further improve the healing process when a patient has an immobilized limb.

Methods:

As stated earlier, my clinical question is "Does unilateral strength training help overall strength gains in an immobilized limb through cross education?" During my article searching process, I used the PubMed database. I used the keywords: cross-education, strength training and immobilized limb. After entering these keywords, I limited my search to articles that were peer reviewed and that had the PDF full text article attached. I included articles that were written in the English language and excluded any articles that were older than six years. After applying the limitations, inclusion and exclusion, the search yielded seven total results and I started the reviewing process.

The final article I chose was pulled from the *Scandinavian Journal of Medicine & Science in Sports in 2013.* The authors of the article include: Alan J. Pearce (corresponding author), A. Hendy, W. A. Bowen, and D. J. Kidgell. Although there was no mention of where the study took place, all of the authors are associated with Deakin University in the city of Melbourne in the state of Victoria, Australia. There were many reasons why I chose this article. Other than matching my clinical question, one reason I chose this article was because the participants in the study were not randomly divided into groups, but rather they were grouped based on relative pre-training strength. Another reason I chose this article was because of a subjective measure used in the study. This particular measure was to survey for the level of compliance demonstrated from the test subjects when it came to abiding by the immobilization rules for the duration of the study. The subjects' compliance was measured on a 0-50 scale and the average score from both tested groups were 20 and 22. This aroused a question of result validity. Finally, the last reason I chose this study was because there was no mention in the

article of the investigators applying study protocol and collecting follow-up data on the experiment.

Results

Summary of the study: The article I have chosen to do my critical assessment over is a study over strength maintenance and the corticospinal adaptations during a strength training regime with an immobilized limb. The purpose of the study is to try to find out if strength training of the uninvolved limb can retain/improve strength in the immobilized limb and also the corticospinal activation following three weeks of single arm curl exercises. Participants were divided into three groups: a control group, a group with one immobilized limb + no training, and one group of people with an immobilized limb + training. All subjects were evaluated on elbow flexion strength, isometric elbow contraction, muscle thickness, single pulse TMS applied to the contralateral limb, and ultrasound to test muscle thickness. After three weeks of training, or non-training, depending on the group, all the subjects were re-evaluated in these categories. The findings included the increase of strength and maintenance of size in both the uninvolved and the involved limb in the immobilized + training group. The results also included a decrease of strength and size in the immobilized limb for the immobilized + no training group. For the corticospinal results, these included that for the immobilized + trained group, the corticospinal response went up in both the involved and uninvolved limbs. As for the immobilized + no training group, the immobilized limb had a reduced corticospinal response.

Appraisal of the study introduction: The introduction section of the article is mostly comprehensive and well written. The literature review of cited sources provides an in-depth

analysis of relevant studies dealing with cross-education training, and how it is proven to be an effective intervention for people with an immobilized limb. The author mentioned that this study will be aimed to recreate a different experimental study mentioned in the introduction however, the author has used sound rationale when designing the additional sections of this study. The independent variables in this study include: the intervention exercise program, the immobilized limb and the control group. The dependent variables include: the adherence to the immobilization program, the quality of the workouts, the overall muscle changes, and the corticospinal reactions to the workout regime. There are some sections of the study that could have been elaborated on. The main aspect I would like to see elaborated is a more detailed explanation of corticospinal responses to exercise and how the TMS will be administered to the subjects. Another section of the introduction that is of question is part of the literature review. Many of the sources cited are ten to twenty years old or older. I would consider these sources to be outdated. Also, the author was involved in one of the sources cited so some bias could be involved when referencing this article.

Appraisal of the study methods: The research design of this study is prospective, experimental and longitudinal over a span of three weeks. In total, there were twenty-eight participants recruited for the study. These participants were divided into three groups based on relative strength. The three groups included a control group, an immobilized + no training group and an immobilized + training group. The groups were all strongly right handed and healthy but not strength trained. This study is a between subject design, because not every participant is exposed to the same testing criterion. The experiment was explained well and could be replicated in the future. The main statistical analysis of the study was averages in muscle strength and thickness

and their standard deviations. As for the corticospinal responses, the statistics provided were based on MEP/M-wave (motor-evoked potential) % at AMT (active motor threshold). Some of the weaknesses of the methods include the statistical analysis and the lack of explanation of the MEP/M-wave at % AMT statistic, the lack of mentioning of any blinding by the participants or clinicians which could result in some bias during the study. Another weakness was that there was no mention of subject attrition, and finally, the measurements of the muscle thickness were done manually by applying a certain amount of pressure with an ultrasound machine. The amount of pressure and different techniques could vary between clinicians, although it was mentioned that the reproducibility was tested, and there was no significant differences, the original test could have been erroneous.

Appraisal of the study results: The results section is well written and flows in the same order as the methods section. Each hypothesis is mentioned to some degree, and all the outcome measures in the methods were presented. All the tables are clear and represent the threshold of *p* value that is clinically significant at $p < .05$ and also used is the Bonferroni $p < .016$. The clinically significant results, as stated in the article included: For the left arm in the immobilized + no training group following intervention, there were significant decreases in both strength and isometric contraction force. For the non-immobilized limb (right arm) in the immobilized + training group there was a significant increase in both strength and isometric contraction. For the immobilized + no training group the muscle thickness in the left arm and right arm deceased significantly. Analysis also showed that the corticospinal responses reduced significantly in the immobilized + no training group at all intensities. Analysis also showed that corticospinal responses significantly increased in the immobilized + trained group at all intensities. While the

muscle strength change measurements are significant, some of the muscle thickness measurements that were deemed clinically significant were only changes of one to two millimeters so the level of actual clinical significance is questionable.

Appraisal of the study discussion: The authors of the study provided a thorough explanation of the results that took place and some possible reasoning behind why the results happened. The authors provide a sound conclusion reflecting all their results as well as addressed a future study. The authors state that the future studies should look at the effects of cross education on lower extremity immobilization, as well as those people with chronic unilateral injury. The authors also stated that the amount of new evidence on this topic provides a need to do research on people with real immobilization injuries. The limitations of this study as mentioned by the authors was that the immobilized limb was not monitored by EMG during the training sessions. This could show if the immobilized limb is actually remaining inactive. The other limitation is that the results of the study did not provide data on the mechanism responsible for the corticospinal adaptations.

Discussion:

This article is clinically significant, because immobilization of a limb after a trauma is very common in the medical world. As physical therapists, we will be dealing with many people who have immobilized limbs. Being that the study helped further reinforce that cross-education from the strengthening of the non-immobilized limb does work for maintenance and some strength gains in the immobilized limb, this can be one of the many tools we use to start the rehabilitation process for that patient. This article also begins to answer the question of why the

cross education takes place by involving the corticospinal adaptations aspect. This article is relevant to my question because it answers, to a degree, whether or not cross-education is effective at maintaining and building strength in the involved limb.

The potential benefits of this study include: further indication that cross education training is a valid intervention for patients with an immobilized limb, as well as more evidence behind why and how cross education training works. The risks of this training could include injury to the un-involved limb which could cause more problems for the healing process and activities of daily life. Even with the risk of injury, I think that the results from this, and other literatures, prove that the benefits outweigh the risks. Further evidence on corticospinal mechanisms could further improve this argument.

I believe there is enough evidence to provide to patients/clients to prove that this is a valid intervention, because the research was conducted properly with few areas of critiquing. I could see myself implementing this intervention appropriately, considering this is not a complicated technique and does not require a multitude of resources.

In conclusion, this article was completed well with little areas of interest. With exception to the few weaknesses mentioned earlier, I believe this article further proves that cross education is a valid intervention and should be implemented to patients who are able.

References

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